DOI:10.1111/j.1477-2574.2011.00343.x

HPB

ORIGINAL ARTICLE

Radiologic and intraoperative detection of need for mesenteric vein resection in patients with adenocarcinoma of the head of the pancreas

Matthew R. Porembka[1,3], William G. Hawkins[1,3], David C. Linehan[1,3], Feng Gao[2,3], Changqing Ma[4], Elizabeth M. Brunt[4] & Steven M. Strasberg[1,3]

[1]Section of Hepato-Pancreato-Biliary Surgery, Department of Surgery, [2]Division of Biostatistics, [3]Siteman Cancer Center, and [4]Department of Pathology and Immunology, Barnes–Jewish Hospital and Washington University in St Louis, St Louis, MO, USA

Abstract

Objective: The need for mesenteric venous resection (MVR) is determined by a combination of preoperative radiologic and intraoperative surgical assessments. A single-centre review was performed to determine how efficient these processes are in evaluating the need for MVR.

Methods: A retrospective study was performed of 343 patients who received resection for adenocarcinoma of the head of the pancreas, 100 of whom underwent MVR. Three radiologic signs (abutment, fat plane obliteration, focal narrowing) were evaluated for their ability to predict the need for MVR. Pathologic assessment was performed to determine if MVR had been necessary to achieve negative-margin (R0) resection. Microscopic tumour in the vein wall, or within 1 mm of the vein wall, was considered to indicate that MVR had been necessary to achieve an R0 resection.

Results: Radiologic evaluation (showing any of the three signs) had sensitivity of only 60%. Overall, 40% of the patients who required MVR showed none of the signs. Specificity was 77%. A total of 80% of patients who underwent MVR had either microscopic invasion or abutment. R0 resection at the vein margin was achieved in 98% of patients in both the MVR and non-MVR groups.

Conclusions: Preoperative radiologic evaluation is not highly reliable in predicting the need for MVR. Therefore, surgical teams performing resections of cancers of the head of the pancreas must be skilled in MVR as the need for this procedure may arise unexpectedly. Surgical assessment of the need for MVR has an accuracy of about 80% and is nearly 100% accurate in determining when MVR is not required.

Keywords

pancreatic cancer, Whipple procedure, mesenteric vein resection, pancreatoduodenectomy

Received 10 March 2011; accepted 22 May 2011

Correspondence

Steven M. Strasberg, 1 Barnes–Jewish Plaza, Box 8109, 1160 NWT, St Louis, MO 63110, USA. Tel: + 1 314 362 7147. Fax: + 1 314 367 1943. E-mail: strasbergs@wustl.edu

Introduction

Carcinomas of the head of the pancreas frequently invade the superior mesenteric and portal veins. Early in the evolution of the Whipple procedure, venous invasion was considered to be a contraindication to resection. However, during the last 20 years many case series have documented the feasibility of mesenteric venous resection (MVR) during a Whipple procedure to remove cancer invading the veins.[1–18] These studies have been summarized in three systematic reviews.[19–21] Despite the inevitable variability in reporting that accompanies a large group of case series, the evidence supports the conclusion that pancreaticoduodenectomy with MVR is as safe and as oncologically effective as pancreaticoduodenectomy in which MVR is not required.

Most of the case series reporting MVR come from large tertiary referral centres, yet many, if not most, Whipple procedures are performed outside such institutions. There are few data on how

This paper was presented at the American Hepato-Pancreato-Biliary Association 11th Annual Meeting, Miami, FL, USA.

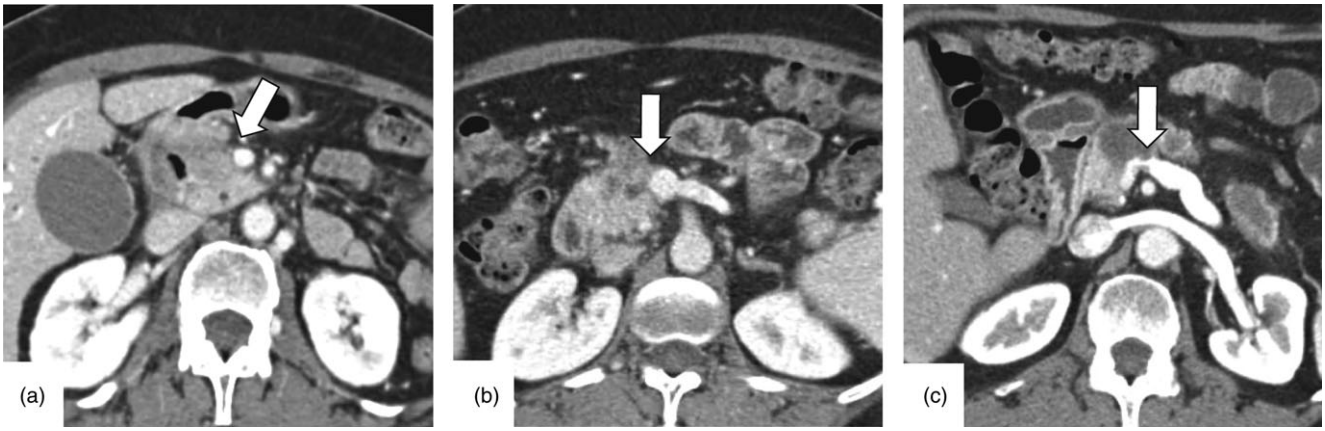

Figure 1 Radiologic findings used to assess need for mesenteric vascular resection in this study. (a) Abutment of tumour to vein without loss of fat plane. (b) Loss of fat plane. (c) Narrowing of vein by tumour. 'Beaking' was also considered to be in this class

frequently MVR is undertaken in these centres, and whether patients requiring MVR are selected for referral, or, if operated are considered unresectable at exploration. In part, this reflects the issue of how often it is actually possible to preoperatively identify patients with tumours that need MVR. If this evaluation were highly reliable, then selective referral would be a reasonable option as the need to perform MVR in non-referred patients would be infrequent. However, if it were not highly reliable, it might be concluded that all Whipple procedures for cancers of the head of the pancreas should be undertaken in centres skilled in MVR. A related issue concerns the efficacy of intraoperative surgical evaluation of the need for MVR. It is unclear how often MVR is really necessary and how often the surgeon is misled by operative findings into thinking that it is required. This paper reviews the Washington University experience with MVR in 343 Whipple resections for adenocarcinoma of the head of the pancreas, with special reference to these issues.

Materials and methods

Patients

Data for all patients who underwent pancreaticoduodenectomy or total pancreatectomy for adenocarcinoma of the head of the pancreas from October 1998 to May 2008 were selected from an institutional pancreaticoduodenectomy database. Since 2007, the database has been prospectively maintained. The database and studies derived from it are approved by the institutional review board. Patients were divided into two groups (MVR and no-MVR groups) according to whether or not a vascular resection had been performed.

Preoperative imaging

The purpose of this review was to evaluate the ability of high-quality standard imaging to detect vascular invasion preoperatively. Computed tomography (CT) scans performed at Washington University were chosen for this purpose. Scans performed at outside institutions and a small number of magnetic resonance imaging (MRI) scans performed in patients with allergies to contrast material were not included in the study. A system for classifying radiologic signs associated with radiographic venous invasion was developed using previously published reports[22–27] (Fig. 1). Venous involvement on CT was categorized as one of three types. 'Abutment' was considered to be present when the tumour was adjacent to the vein, but the fat plane between the pancreas and vein was preserved. 'Fat plane obliteration' referred to the loss of the fat plane, and 'narrowing' was indicated when the tumour exerted mass effect on the vein, thereby narrowing or distorting the shape of the vein. Narrowing was considered to be present even when it consisted only of 'beaking' of the right lateral margin of the vein.

Operative procedures

A Whipple procedure with antrectomy was the standard procedure performed. Frozen sections of the pancreatic neck and bile duct margins were obtained routinely in the resected specimen. If the pancreatic neck margin was positive, additional pancreas was resected until a negative margin was obtained, or total pancreatectomy was performed. The decision to perform vein resection was made at the discretion of the operating surgeon and was based on preoperative imaging, as well as intraoperative findings. In patients in whom narrowing was clearly demonstrated on preoperative imaging, the decision to perform vascular resection was made preoperatively. When the preoperative finding of vascular involvement was less than narrowing, a trial dissection of the mesenteric veins was performed after the division of the neck of the pancreas. In this situation, the decision to perform vascular resection was based on visual or palpable evidence of tumour invasion or an unusual adherence between the vein and the specimen at a point of suspected tumour invasion. Ninety-eight per cent of the procedures were performed by four members of the

Section of Hepato-Pancreato-Biliary Surgery, Department of Surgery, at Barnes–Jewish Hospital/Washington University in St Louis.

The technique for MVR was based on the extent of vascular involvement. When approximately one-third or less of the vessel diameter was involved on the right side wall of the superior mesenteric or portal vein, a partial wall resection without graft was performed. When possible, the defect was closed transversely to reduce narrowing of the vein, as described by Clavien and Rudiger.[22] When more of the vein wall was involved, a partial wall resection with graft or a cylindrical sleeve resection was performed. In the latter case, the superficial femoral vein was used for the vein graft if a primary end-to-end anastomosis was not possible.

Pathologic analysis

Surgical specimens were inked in the operating room in the presence of a pathologist. Four inks of different colours were used for the pancreatic neck margin, mesenteric vein margin, uncinate margin and posterior margin (Fig. 2). When a venous resection was performed, the intimal surface of the vein was not inked (i.e. the intravascular surface of the vein was not considered to be a margin). Frozen sections of the bile duct and pancreatic neck margin were obtained and the specimen was then formalinized. All margins were microscopically evaluated and graded as R0 (microscopically negative) or R1 (microscopically positive or tumour within 1 mm of the vessel wall). There were no R2 resections.

When possible, the specimens were evaluated for proximity of the tumour to the vein using the following criteria: microscopic tumour within the vein wall ('microscopic invasion') (Fig. 3a); tumour within 1 mm of the vein wall ('microscopic abutment') (Fig. 3b), and tumour further than 1 mm from the vein wall (Fig. 3c). Either of the first and second results were considered to indicate that MVR had been necessary to obtain an R0 resection margin.

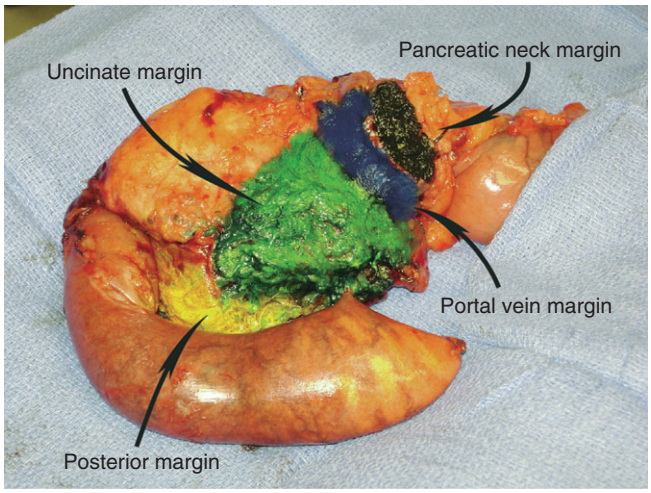

Figure 2 A standardized four-colour inking system was used to reproducibly assess microscopic margins. The specimen was marked immediately after extirpation by the surgeon in the presence of the pathologist

Statistical analysis

The distributions of demographic and clinical characteristics in patients undergoing MVR vs. standard resection were compared using chi-squared analysis, Fisher's exact test, Mann–Whitney *U*-test or *t*-test where appropriate. Overall survival (OS) was defined as the time from surgery to the date of death from any cause; survivors were censored at the date of last contact. The time to death was described using the Kaplan–Meier product limit method and compared using the log-rank test. All analyses were two-sided and significance was set at a *P*-value of 0.05. Statistical analyses were performed using SAS Version 5.0 (SAS Institute, Inc., Cary, NC, USA). For the purposes of analyses, tumour–node–metastasis (TNM) stages were grouped (stages Ia/Ib, stage IIa, stages IIb/III/IV) in order to obtain adequate sample sizes.

Results

A total of 845 patients underwent pancreaticoduodenectomy or total pancreatectomy during the study period. Of these procedures, 343 (41%) were performed for pancreatic adenocarcinoma. The median age of patients with pancreatic carcinoma was 65.9 years (range: 36.0–86.1 years) and 51% of patients were male. The rate of endoscopic ultrasound (EUS)-guided biopsy was equivalent in both groups [47/100 (47%) in the MVR group vs. 101/243 (42%) in the non-MVR group] and there was no association between EUS-guided biopsy and need for MVR ($P = 0.210$).

Operative procedures

The operations performed were a standard Whipple procedure with antrectomy in 284 patients (83%), a pylorus-preserving Whipple procedure in 33 patients (10%) and total pancreatectomy in 26 (8%) patients (Table 1). Mesenteric vein resection was performed in 100 of the 343 (29%) procedures and was associated with longer mean operative time and a moderately prolonged length of stay. Thirty-day mortality was not higher in patients who underwent MVR (2% in both the MVR and non-MVR.

Partial wall resection without graft was performed in 56 of 100 patients, partial wall resection with graft in 14 of 100 patients, and cylindrical sleeve resection in 30 of 100 patients (Table 1). There was no difference in patient age, tumour stage or tumour size among patients undergoing the various types of venous resection. In addition, there was no association between operative time, blood loss or length of stay (Table 1). All types of vein resections were equally effective in obtaining R0 resection and no differences in 30-day mortality or median survival were found.

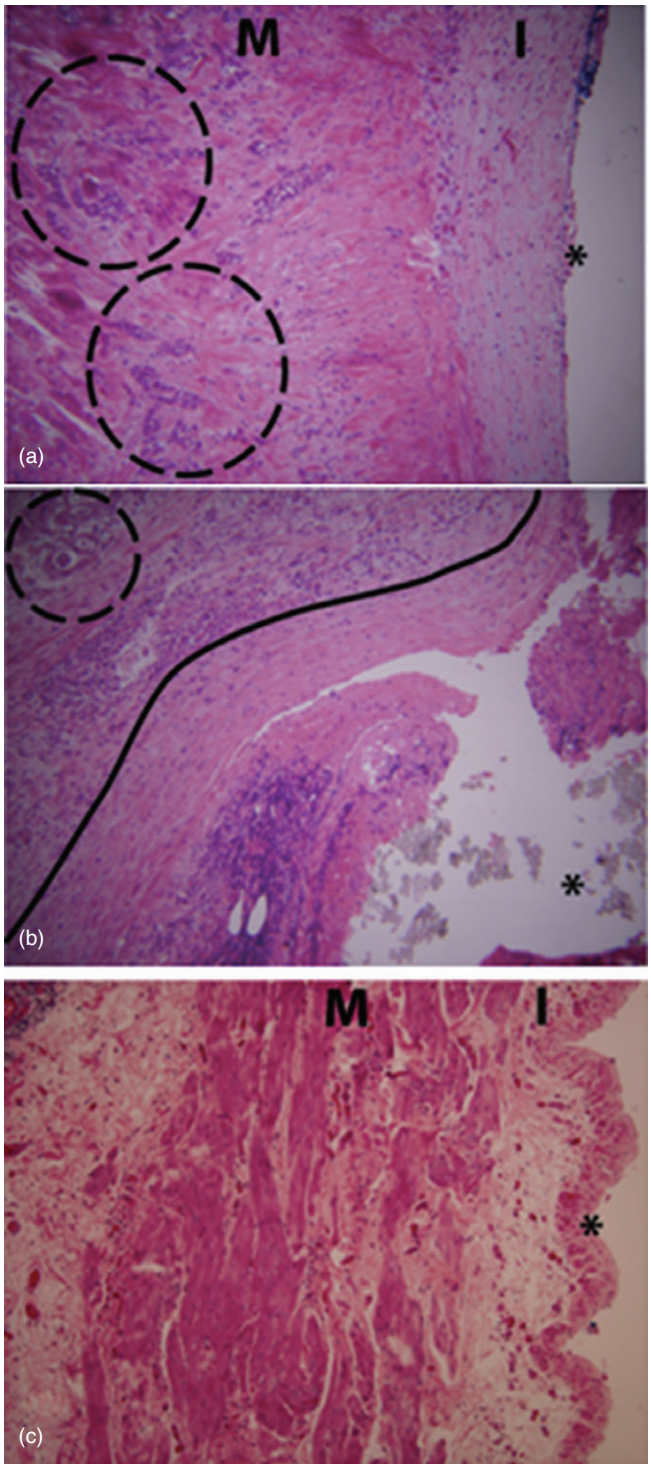

Figure 3 Degree of vein involvement by tumour. (a) Tumour invasion of the vein wall. The tumour (circled) can be seen within the media of the vein wall. (b) Tumour abutment of the vein. The black line indicates the limit of the vein wall. The tumour (circled) lies just outside the vein wall. (c) No involvement of the vein by tumour. The tumour is ≥1 mm from the edge of the vein. *, luminal surface; M, media of the vein; I, intima of the vein. (Haematoxylin and eosin stain; original magnification ×200)

Ability of preoperative radiologic findings to predict need for MVR

Evaluable radiologic findings were available for 213 patients; these are displayed in Table 2. A total of 25 patients had preoperative MRI rather than CT scans and 140 patients had been referred to Washington University with previously completed scans. As noted, these were not included in the study. However, 35 (25%) of the patients referred with CT scans underwent repeat CT, usually because the scans which had accompanied the patients were not adequate for tumour staging. Vein narrowing, which achieved specificity of 99%, proved to be the most specific test (i.e. vein narrowing was almost never seen in patients who did not require MVR). However, its sensitivity was very low at 20%, indicated by the finding that 80% of patients who were found at operation to require MVR did not show vein narrowing on preoperative imaging. The positive and negative predictive values of vein narrowing were 92% and 77%, respectively. The presence of any of the three radiologic signs improved the sensitivity to only 60%. Additionally, specificity dropped to 77% when all three radiologic signs were considered. The positive and negative predictive values for any radiographic sign were 49% and 84%, respectively. Consequently, 40% of patients who were deemed to need MVR at operation did not have a preoperative radiologic sign indicating that need.

Pathologic findings relating to need for MVR

Patients who required MVR had tumours that were significantly larger than patients who did not (non-MVR group, 2.99 cm; MVR group, 3.40 cm; $P = 0.029$) (Table 3). At least one positive resection margin was present in 88 of the 343 (26%) study subjects and this figure remained almost constant whether or not a vein resection was performed. However, positive margins at the portal/superior mesenteric vein were present in only 2% of patients in each group. More commonly, resections were deemed R1 as a result of positivity at the uncinate (14%) and neck (6%) margins; these results were similar in both patient groups. However, there was a significantly higher posterior positive margin rate in the MVR group [9/100 (9%) vs. 4/263 (0.02%); $P = 0.021$, Fisher's exact test], possibly because the tumours in that group were larger (Table 3).

The relationship of the tumour to the vessel wall could be evaluated in detail in 79 of 100 patients in the MVR group. Microscopic invasion of the vessel wall (Fig. 3a) was seen in 41 of 79 (52%) patients and microscopic abutment of the tumour against the vein wall (i.e. within 1 mm of the vein wall) (Fig. 3b) was seen in 20 of 79 patients (25%). In only 18 of 79 patients (23%) was the tumour >1 mm from the vessel wall (Fig. 3c). In eight of these last 18 patients, the pathology report described inflammatory or desmoplastic change adjacent to the vessel. In 11 of these 18 patients, a partial wall resection without graft had been performed. Therefore, in 61 of the 79 patients (representing 77% of the assessable specimens), the relationship of the tumour to the vein wall was

Table 1 Operative variables and 30-day mortality in patients undergoing pancreatic head resection with and without mesenteric vein resection (MVR)

	All patients *n* = 343 (100%)	Non-MVR group *n* = 243 (71%)	MVR group *n* = 100 (29%)
Type of pancreatic resection			
Pylorus-sparing, *n* (%)	33 (10%)	23 (9%)	10 (10%)
Standard Whipple, *n* (%)	284 (83%)	206 (85%)	78 (78%)
Total pancreatectomy, *n* (%)	26 (7%)	14 (6%)	12 (12%)
Type of venous resection			
Partial, without graft, *n* (%)	–	–	56 (56%)
Partial, with graft, *n* (%)	–	–	14 (14%)
Cylindrical, *n* (%)	–	–	30 (30%)
Operative time, min[a], mean (range)	422 (179–920)	401 (179–715)	474 (237–920)
EBL, ml, median (range)	600 (50–5500)	600 (50–5500)	700 (250–5000)
Transfusion, units PRBC, median (range)	0 (0–9)	0 (0–8)	0 (0–9)
Length of stay, days[b], median (range)	9 (4–61)	9 (4–49)	11 (7–61)
30-day mortality, *n* (%)	7 (2%)	5 (2%)	2 (2%)

[a]Mean operative time in the MVR group was significantly greater than in the non-MVR group ($P < 0.001$, Student's *t*-test).
[b]Median length of stay was significantly prolonged in the MVR group compared with the non-MVR group ($P = 0.021$, Mann–Whitney *U*-test).
EBL, estimated blood loss; PRBC, packed red blood cells.

Table 2 Computed tomography findings in patients undergoing pancreatic head resection with and without mesenteric vein resection (MVR)

	All patients (*n* = 213) *n* (%)	Non-MVR group (*n* = 158) *n* (%)	MVR group (*n* = 55) *n* (%)
Radiographic sign present[a]	67 (31%)	34 (22%)	33 (60%)
Abutment	67 (31%)	34 (22%)	33 (60%)
Fat plane obliteration	21 (9.9%)	9 (5.7%)	12 (22%)
Narrowing	11 (5.2%)	1 (1.7%)	10 (18%)
No mass observed	31 (15%)	28 (17%)	3 (5%)
No sign of venous invasion reported	115 (54%)	96 (61%)	19 (35%)

[a]More than one sign was noted in many patients. For instance, patients with narrowing were usually also noted to have abutment and loss of fat plane in other cuts of the computed tomogram.

such that a positive margin (i.e. R1 resection) would have been obtained without a vascular resection.

These data can also be viewed in relation to the sensitivity and specificity of intraoperative evaluation of the need for MVR. The sensitivity of operative evaluation was about 80% based on the data just discussed. However, that only 2% of the patients in whom MVR was *not* performed were found to have a positive portal vein margin leads to the conclusion that the specificity was 98%.

Durability of the reconstructions

Retrospective review of postoperative radiographic studies, including CT, MRI and duplex ultrasound, demonstrated that most but not all venous reconstructions were durable (median follow-up: 243 days). Evaluable postoperative studies were available for 78 of the 100 patients in the MVR group. Ten patients (13%) were found to have occlusion of the mesenteric venous system (superior mesenteric, splenic and/or portal veins). In six patients, asymptomatic mesenteric venous obstruction was identified. Four patients experienced symptomatic occlusion, all occurring in the immediate postoperative period (<7 days postoperatively). Vague, crampy abdominal pain was reported in three patients, all of whom improved symptomatically with anticoagulation. The fourth patient, who underwent a sleeve resection, experienced intestinal ischaemia, underwent emergent re-operation, and ultimately died of complications related to the acute mesenteric venous occlusion. There was no association between the durability of the venous reconstruction and the type of venous resection ($P = 0.195$). Mesenteric vascular occlusion after repair was not a significant negative determinant of survival.

Table 3 Pathologic variables in patients undergoing pancreatic head resection with and without mesenteric vein resection (MVR)

	All patients (*n* = 343) *n* (%)	Non-MVR group (*n* = 243) *n* (%)	MVR group (*n* = 100) *n* (%)
Tumour size[a]			
<10 mm	3 (1%)	2 (1%)	1 (1%)
10–19 mm	38 (11%)	26 (11%)	12 (12%)
20–29 mm	127 (37%)	100 (41%)	27 (27%)
30–39 mm	94 (27%)	62 (26%)	32 (32%)
≥40 mm	81 (24%)	53 (22%)	28 (28%)
Stage			
Ia	14 (4%)	11 (5%)	3 (3%)
Ib	17 (5%)	14 (6%)	3 (3%)
IIa	66 (19%)	43 (18%)	23 (23%)
IIb	234 (68%)	167 (69%)	67 (66%)
III	5 (1%)	1 (0%)	4 (4%)
IV	1 (1%)	1 (0%)	0 (0%)
Unknown	6 (2%)	6 (2%)	0 (0%)
Grade			
Well differentiated	20 (6%)	15 (6%)	5 (5%)
Moderately differentiated	172 (50%)	118 (49%)	54 (54%)
Poorly differentiated	151 (44%)	110 (45%)	41 (41%)
Resection margins			
R0	255 (74%)	180 (74%)	75 (75%)
R1	88 (26%)	63 (26%)	25 (25%)

[a]Patients requiring vein resection were observed to have significantly larger tumours compared with patients not requiring vein resection ($P = 0.029$, chi-squared analysis).

Survival

The median follow-up time of surviving patients was 56 months. The median OS for all patients who underwent resection for pancreatic adenocarcinoma was 20.6 months [95% confidence interval (CI) 17.5–23.6 months]. Performance of MVR was not associated with decreased survival compared with standard resection (MVR group: OS, 21.4 months, 95% CI 18.2–24.6 months; non-MVR group: OS, 20.0 months, 95% CI 16.0–23.9; $P = 0.710$) (Fig. 4).

Survival was dependent on stage (Fig. 5) and margin status (Fig. 6). Overall, patients in whom R0 resection was achieved had improved survival over those with positive margins. This difference persisted whether or not a vein resection had been performed [MVR group: R1 status, $n = 25$, median survival, 14 months; R0 status, $n = 75$, median survival, 22 months ($P = 0.002$); non-MVR group: R1 status, $n = 63$, median survival, 14 months; R0 status, $n = 180$, median survival, 22 months ($P = 0.001$)].

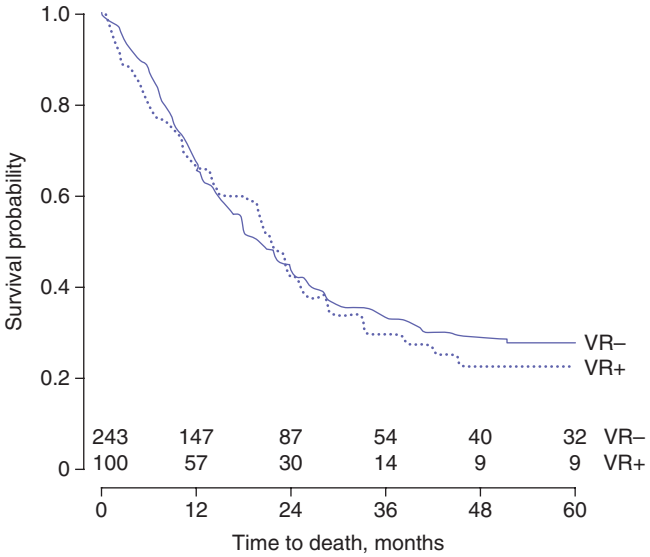

Figure 4 Kaplan–Meier plot of overall survival in patients with (+) and without (–) vein resection (VR) ($P = 0.710$)

Discussion

Many case series have documented the feasibility of MVR during a Whipple procedure to remove cancer invading the veins.[1–18] The approaches used to achieve these resections were developed

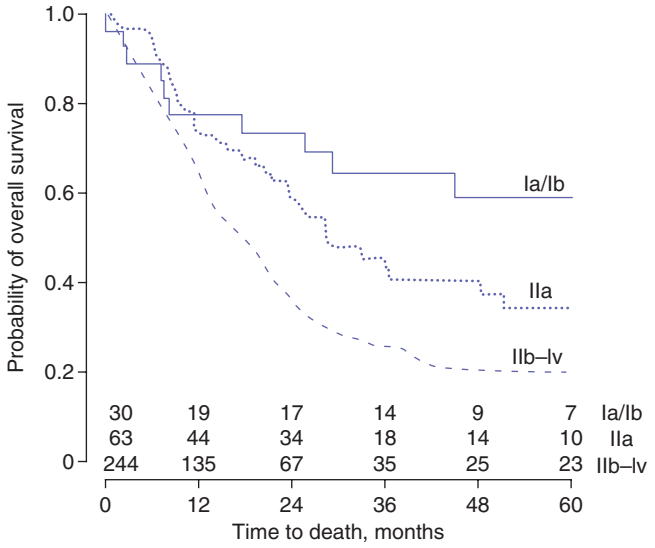

Figure 5 Kaplan–Meier plot demonstrating differences in median survival between patients with stage Ia/Ib (77.9 months), stage IIa (28.9 months) and stage IIb/III/IV (17.9 months) disease ($P < 0.001$)

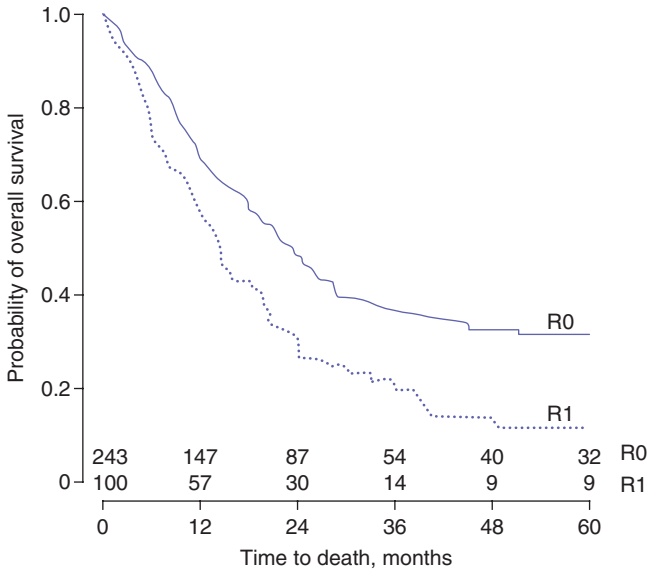

Figure 6 Kaplan–Meier plot demonstrating a significant improvement in survival in patients with R0 resection (23.2 months) compared with those with R1 resection (14.4 months) ($P < 0.001$)

independently within centres with specific interest in locally invasive cancers of the pancreas. Consequently, definitions of resectability vary, as do techniques for resection. In addition, the literature is characterized by important differences in whether and how study variables are reported, in staging methods and in techniques of pathologic evaluation of specimens. For instance, many studies report the incidence of R1 resections,[5,9,10,13,14,16,23–29] but few report the method used to determine resection margin status.[5,16,27–29] Only a minority of papers report using a specific system to analyse pathology specimens. Each of the systems described (General Rules for Cancer of the Pancreas, Japan Pancreas Society; the International Union against Cancer TNM system, and the American Joint Committee on Cancer TNM system) has its own specific criteria for reporting margin status and vascular invasion. In some cases, only the 'retroperitoneal margin' or area of pancreatic tissue adjacent to the small mesenteric artery was inked and analysed.[5,27,28] In other cases, intraoperative frozen sectioning was utilized to determine negative margins.[5,16] Very few groups report the status of all margins[9,16,28] and whether any patients had residual disease at the resected portal vein margin.[13,16] None of this is surprising in what is essentially a case series literature. However, perhaps surprisingly, this literature demonstrates with some consistency two important outcomes: MVR is safe in tertiary centres, and MVR resection is as safe as non-MVR resection. Oncologic outcomes of MVR resections match those of non-MVR resections. This current paper supports similar conclusions. The particular interests of this study were to determine how effectively preoperative radiologic staging can predict the need for MVR and how effectively intraoperative evaluation can determine whether MVR is necessary to achieve R0 resection.

Early strong reliance on CT scans[28] has given way to recognition that CT cannot determine vein involvement in many cases.[30] A number of reports have examined the accuracy of preoperative radiologic evaluation in predicting whether resection of tumour will be possible when mesenteric vascular invasion is present in radiography.[31–35] However, the ability of radiologic assessment to predict the need for MVR preoperatively has not been well studied. Li *et al.* examined this issue, but used somewhat different methods.[31] They demonstrated a similarly poor sensitivity (49–63%), but high specificity (100%) of CT for detecting venous involvement preoperatively (i.e. their findings were similar to those of this study).

Narrowing of the veins by tumour has a high positive predictive value but is present infrequently in patients who require MVR (low sensitivity). When considered as a group, radiologic signs have sensitivity of about 60% and specificity of about 77% for the need for MVR. There are probably several reasons why imaging fails to achieve higher values. Pancreatic cancers can be more infiltrative than mass-forming and, although infiltration may be appreciated by palpation, it may be less evident on radiography. Pancreatic cancers are characteristically differentiated from normal pancreas by the fact that they are hypoattenuating, but this may vary among individual tumours. If so, reduced attenuation of tumour tissue would be especially likely to lead to missed vein involvement in smaller tumours or at the edge of tumours. The clinician's technique and experience in interpretation may be other factors.

These findings lead to the conclusion that preoperative imaging cannot reliably predict the need for MVR, given that 40% of patients in this series who required MVR were not identified by

imaging. The corollary is that, either individually or as a team, surgeons undertaking resections for adenocarcinoma of the head of the pancreas should have the skills required to carry out MVR. These should include the ability to harvest and implant cylindrical vein grafts. Clearly, the alternative of selecting patients for referral to tertiary centres based on perceived need for vein resection on preoperative imaging is not practical as this need is discovered only at the time of surgery in a substantial number of patients.

The rate at which MVR is undertaken to achieve a negative resection during pancreaticoduodenectomy for pancreatic adenocarcinoma has varied from 7% to 79% in the literature.[6,7,9,10,13–15,17,23,25–27,29,36–42] In the current series, 29% of the pancreaticoduodenectomies were performed with venous resection. Postoperative pathologic examination showed that 80% of resections had been performed for tumours that either invaded the vein or were within 1 mm of the vein, albeit that not all specimens could be assessed. The vein margin was positive only in 2% of these patients. Furthermore, the vein margin was positive in only 2% of patients who were thought not to need MVR. This shows that the decision of whether a patient did not require MVR was almost always correct. Although intraoperative judgement of whether a patient did need MVR is not quite as good (80%), it is still very acceptable, especially as the procedure is safe. It may be possible to improve on this value by using EUS or intraoperative ultrasound to guide decisions. Palpation is the primary factor in surgical decision making. In a disease in which inflammation and tumour may co-exist, differentiating between these may at times be difficult. In retrospect, it seems that the decision to perform MVR was frequently made in cases of doubt.

This study has several limitations. As a retrospective review, it is dependent on the quality and accuracy of the medical record. Preoperative radiographic reports were used to determine the presence of invasion. This is likely to have resulted in lower sensitivity than that found in other published series that used specific criteria and multiple radiologists to quantify potential vascular invasion.[31,33,35,43] However, the purpose of this review was to determine the accuracy of standard reporting techniques that are used in practice to determine vascular invasion. All the reports examined for this series were generated by dedicated abdominal CT radiologists at a single institution and represent state-of-the-art interpretation at the time the studies were made. Therefore, we believe that this approach represents a more real-world evaluation of the utility of the scans. Despite these limitations, the main conclusions of the paper pertaining to the issues of preoperative radiologic staging and pathologic findings after resection would appear to be sound.

The importance of achieving an R1 resection has been debated in the literature.[24,27,44–57] Studies have produced conflicting results on whether R0 resection results in improved survival. This variability probably reflects comparisons of disparate patient populations, variability in specimen processing, and sampling error during margin analysis. The data presented suggest that the issue is still important in this disease, in which adjuvant therapy is of limited effectiveness.

In summary, standard radiologic reporting techniques in a tertiary care centre were found to have sensitivity of 60% in detecting the need for MVR. Pathologic analysis showed that 80% of patients who actually underwent MVR would have attained positive margins without it. As the need for MVR is not predicted with high reliability preoperatively, surgical centres performing Whipple procedures for pancreatic adenocarcinoma should be prepared for and capable of performing MVR.

Acknowledgement

The Siteman Cancer Center is supported by the National Cancer Institute (NCI) Cancer Center Support Grant (P30 CA91842).

Conflicts of interest

None declared.

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